



Ontario

MINISTRY OF ENVIRONMENT AND ENERGY SCIENCE AND TECHNOLOGY BRANCH AQUATIC SCIENCE SECTION



STB Technical Bulletin No. AqSS-8
August 1996

THE LIMNOLOGY OF LAKES MUSKOKA, JOSEPH AND ROSSEAU: A COLLABORATIVE STUDY WITH MNR

HISTORY

Three of the largest lakes in Muskoka, Joseph, Rosseau and Muskoka, are among Ontario's most valuable aquatic resources. The almost 900 kilometres of shoreline have been used for vacation properties and as a tourist destination for well over 100 years. Today, the developed portions of the shoreline represent some of Ontario's most valuable real estate. The lakes themselves support excellent warm and cold water fisheries and provide angling opportunities on a year round basis.

The close links between water chemistry, shoreline development and many aspects of fisheries biology prompted a collaborative study between MOEE and MNR to more efficiently evaluate stressors affecting the Muskoka Lakes and ultimately protect this valuable resource. Beginning in 1993, staff from MOEE joined with the MNR Muskoka Lakes Fisheries Assessment Unit (FAU) in Bracebridge to form the collaborative Muskoka Lakes Aquatic Assessment Unit (MLAAU). This cooperative effort allowed the integrated study of a wide spectrum of water quality parameters and biological indicators, including fisheries data between 1993 and 1995. The program addressed potential ecological responses to eutrophication, acidification, physical alterations of the shoreline and exploitation of sport fish. The results of this collaborative study document the present state of these Muskoka Lakes, allow comparison with previous work and serve as a baseline for future studies. It will also facilitate development of optimal sampling strategies for transfer to other assessment projects.

WATER CHEMISTRY

Prior to this joint MOEE-MNR study, other investigations of the 3 lakes had been carried out. The first major limnological survey of the lakes was completed by

MOEE in 1973. At that time, the major concern was the eutrophication of Gravenhurst Bay which had resulted from excess phosphorus input from the Gravenhurst sewage treatment plant. Between 1973 and 1978, the MOEE monitored and reported on the effects of phosphorus removal on the trophic status of Gravenhurst Bay. In 1986, staff of the Dorset Environmental Science Centre (MOEE) reexamined water quality indicators in the Muskoka Lakes. The study concentrated on dissolved oxygen, trophic status, and sensitivity of the lakes to acidification at 37 stations on lakes Joseph, Rosseau and Muskoka (Fig.1).

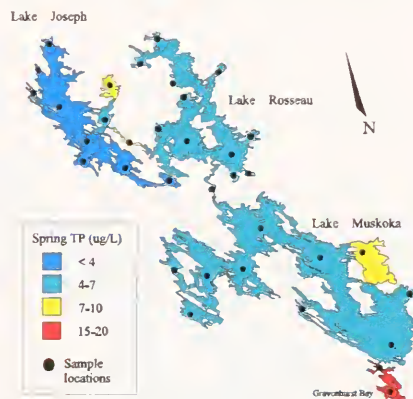


Fig. 1. Long-term, spring turnover total phosphorus concentrations and MLAAU sample locations.

Several of the stations were chosen for comparison with the 1973 study. Sampling continued until 1989 but many of the stations that shared similar water chemistry characteristics were discontinued after 1986. Between 1990 and 1992 water quality data were collected only in the area around

Gravenhurst Bay to determine background conditions prior to a planned upgrade to the Gravenhurst STP. Sample locations and the parameters collected vary widely for each of the study years and are described in detail elsewhere.

Historical sample locations and sample frequencies were reviewed to establish sampling protocols for the collaborative study in 1993. Trophic status indicators were sampled frequently from a small subset of sensitive or important sites, while characterization of ion chemistry was done less frequently at a larger number of sites. A comprehensive, water quality database was constructed that can be used to describe temporal and spatial variation as well as steady-state concentrations for a wide variety of parameters. As an example, the long-term, between-lake differences in selected parameters are shown in Table 1.

Table 1. Open water, long-term, ice free means for selected parameters for Lakes Joseph, Rosseau and Muskoka.

Lake	TP ($\mu\text{g/L}$)	Chl a ($\mu\text{g/L}$)	Secchi (m)	DOC (mg/L)	Cond (μS)
Joseph	3.3	1.2	8.4	2.0	54
Rosseau	4.6	1.7	6.3	2.8	47
Muskoka	5.9	1.9	4.6	3.8	48

Detailed observations indicated the following:

1. Water quality in Gravenhurst Bay continues its twenty-year trend of improvement as a result of upgraded sewage treatment in the 1970s and 1980s and relocation of the STP outfall to South Bay on Lake Muskoka in 1995. (Fig. 2). There has been no impact of the first two years of discharge into South Bay on water quality in the main basin of the lake. It is important that monitoring should continue.

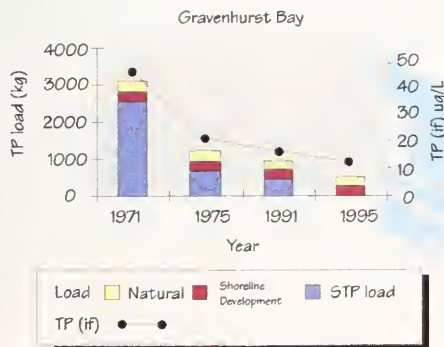


Fig. 2. Total phosphorus loads and ice-free total phosphorus (TPif) concentrations for Gravenhurst Bay since 1971.

2. The basin of Lake Muskoka at the mouth of the Muskoka River is richer in nutrients and shows more oxygen depletion than the rest of the main lake basin. Little Lake Joseph is also enriched by comparison with the rest of Lake Joseph.

FISHERIES AND BIOLOGY DATA

Fisheries data collected for the core requirements of MNR's FAU network included index netting programs for large fish in the spring and fall, creel census of sport fish in winter and summer, surveys of sport fish spawning activity in summer and autumn and characterization of small fish communities in the summer. Fisheries data are collected to validate specific management initiatives in these Muskoka Lakes and to support other initiatives in similar lakes on a province-wide basis. Demonstrating improved recruitment of lake trout following the cessation of stocking on Lake Rosseau (Fig. 3) is one example of the usefulness of this type of data to both managers of fish stocks in the Muskoka Lakes and for fisheries management implications on a province wide basis.

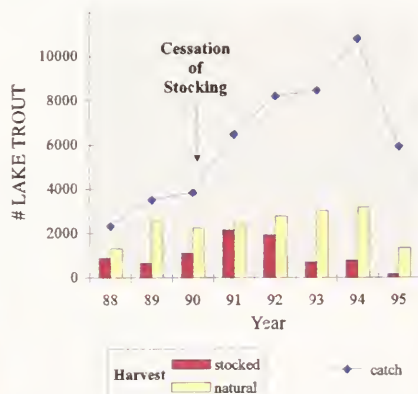


Fig. 3. Lake trout recruitment in Lake Rosseau following cessation of stocking.

Monthly samples of phytoplankton and zooplankton were collected at 19 stations throughout the Muskoka Lakes during each ice-free season. Numeric ordination methods are being used to characterize these communities, compare them to those in other Ontario lakes and to determine their responses to stress.

A specific zooplankton protocol was developed to track the demographics and impacts of the invading zooplankton, *Bythotrephes cederstroemi*. Water clarity declined in all three Muskoka Lakes, and particularly in Lake Rosseau, following the introduction of *Bythotrephes cederstroemi* in the late 1980s (Fig. 4). Preliminary data suggest alterations in the zooplankton community which are similar to those reported in other invaded lakes. In addition, the growth dynamics of lake trout and lake herring appear to have changed since invasion. Different population demographics of *Bythotrephes* between

Lakes Muskoka, Rosseau and Joseph may reflect relative differences in zooplanktivorous fish populations.

The benthic communities of the littoral zone were sampled in the fall of 1993-94 using techniques developed by the Department of Fisheries and Oceans and the Dorset Environmental Science Centre. Sample sites were coordinated with small fish survey sites to increase the ecological integrity of each metric. A related cooperative study with the University of Toronto used underwater video photography to determine the near shore movement patterns of fishes in relation to shoreline alteration.

Muskoka Lakes

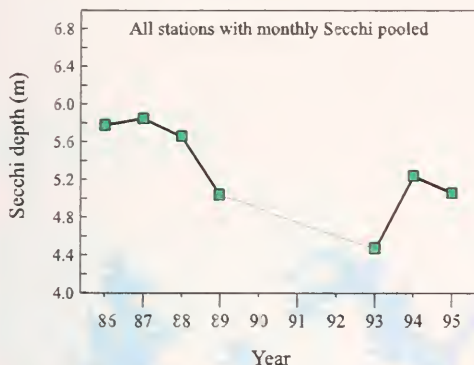


Fig. 4 Changes in water clarity since 1986 in the Muskoka Lakes.

WATERSHED DEVELOPMENT

Extensive mapping of littoral substrate features and shoreline development patterns have been completed for the entire shoreline of the Muskoka Lakes. About 15% of the shoreline of the Muskoka Lakes has been altered by humans, mostly through construction of docks and boathouses (Fig. 5). Although these appear to have impacts on fish, long-term implications are uncertain and are worthy of further study.

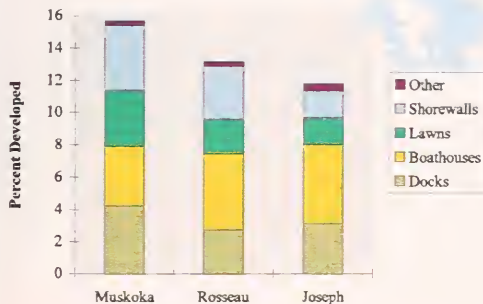


Fig. 5. Percent of shoreline developed by specific features.

Benthos and fish studies can ultimately be linked with the mapping of littoral substrate, aquatic macrophytes and shoreline development. Taken together, these studies will further our knowledge of development impacts on sensitive littoral areas.

SUMMARY

There is great value in integrating chemical, physical and biological indicators of water quality into an ecosystem-scale assessment. It appears both necessary and possible to design and carry out cost-effective long-term ecological monitoring programs on Ontario's large lakes, and partnerships appear to be an effective means of doing this. The existing FAU network of MNR has been a logical partner in these studies.

For further information, contact:

Neil Hutchinson or Bev Clark

Phone: 705 766-2418

Fax: 705 766-2254

Email: clarkbe@epo.gov.on.ca

hutchin2@epo.gov.on.ca

Persons requiring details about fisheries assessment should contact:

Warren Dunlop

Ministry of Natural Resources

Muskoka Lakes Fisheries Assessment Unit

R.R. #2

Bracebridge, Ontario P1L 1V3

Phone: 705 645-8747

Fax: 705-645-8372

Email: dunlopwa@epo.gov.on.ca

